

LOW TEMPERATURE EVALUATION OF THE UCC1802 LOW POWER BiCMOS CURRENT-MODE PWM

Test Report

Ahmad Hammoud
QSS Group, Inc.

&

Scott Gerber
ZIN Technologies

&

Malik Elbuluk
University of Akron

NASA Glenn Research Center
Cleveland, Ohio

May 29, 2001

Low Temperature Evaluation of the UCC1802

Low Power BiCMOS Current-Mode PWM

Background

The Texas Instrument/Unitrode UCC1802 is a high-speed, low power BiCMOS current-mode pulse width modulation (PWM) control integrated circuit[1]. It has the capability of providing 100% duty cycle at frequencies up to 1 MHz. Its operating temperature is specified in the range of -55 to +125 °C. This extended temperature capability renders the device a potential candidate for use as switching control in low temperature dc-dc converter and other applications. The performance of the BiCMOS-structure devices at low temperature is questionable. Typically, CMOS devices perform relatively well down to approximately liquid nitrogen temperature (-196 °C). Bipolar devices, on the other hand, are known to suffer performance degradation at low temperature. BiCMOS devices are a hybrid of these two families and their performance at extreme low temperatures is not known.

Test Setup

A circuit board, populated with the UCC1802 chip and few passive components, was designed and built for evaluation in the temperature range of +25 °C to -190 °C. Performance characterization included switching frequency and duty cycle. The UCC1802 current-mode PWM controller was tested under the following conditions:

- Oscillator frequency was set to approximately 100 kHz
- The UCC1802 chip, which is nominally a current-mode controlled device, was instead made to vary by voltage-mode control. This was achieved by applying a sawtooth ramp to the current sense input via an additional RC network [2].
- Compensation (COMP) pin was tied to error amplifier input (FB) pin.
- The duty cycle of the output was controlled by applying an external voltage (control voltage level signal) to the error amplifier input (FB) pin.
- VCC supply driven by a low impedance power source with current limited to 30 mA. The current limiting is recommended in order to prevent over-current conditions for the on-chip zener diode [3].

Results and Discussion

Testing of the device was initially performed at 25 °C after which measurements were taken at three additional temperatures; -100 °C, -150 °C, and -170 °C. At each test temperature, the device was allowed to soak for 15 minutes before measurements were made. The value of the applied input voltage VCC had to be set to greater than 12 V for the device to turn on. With the supply current limited to 30 mA, an input voltage VCC of 13 V was applied.

At room temperature, the maximum duty cycle obtained was 95% at a control voltage level (FB) of 1.7 V. Upon lowering the test temperature, the value of the control voltage level (FB) required to obtain a specific duty cycle decreased significantly. For example, the values of this signal required for a 50% output duty cycle were about 1.4 V, 1.0 V, 0.8 V, and 0.7 V at 25 °C, -100 °C, -150 °C, and -170 °C, respectively. The effect of the control voltage (FB) on the duty cycle of the device output is shown in Figure 1 at the various test temperatures.

While a shift occurs in the control voltage signal with decreasing test temperature, the switching frequency does not change significantly. The resulting frequencies as a function of temperature are listed in Table I. It is important to note that at the intermediate temperatures, i.e. -100 °C and -150 °C, some loading effects on the power supply take place as evident by the drop in the value of VCC as well as the increase in the supply current ICC, as shown in Table I. It is believed that the clamping voltage characteristics of the on-chip zener diode might have experienced changes with temperature and this, in turn, resulted in an increase in the supply current. At temperatures between -170 °C and -175 °C, the device exhibits instability in performance in the form of intermittent loss of the output signal. Beyond -175 °C, the device ceases to operate but recovers as soon as temperature is brought back to about -170 °C.

Conclusion

The UCC1802 low power current-mode PWM controller, which is a military-grade device rated for -55 to +125 °C operation, has been evaluated for potential use in low temperature applications. The results from this preliminary work indicate that while the device is capable of withstanding temperatures as low as -170 °C, its usefulness depends on whether the shift in the control voltage signal (FB) with temperature is tolerable in the specific application or if some feedback compensation is provided to accommodate for these low temperature induced changes. Further comprehensive testing is, however, required for a complete assessment of the performance and stability of the device under long term temperature conditions.

References

1. UCC1802 Low Power BiCMOS Current-Mode PWM Data Sheet, Texas Instruments, Inc.
2. Unitrode Corporation Application Note U-133A.
3. Unitrode Corporation Application Note DN-65, 6/95.

Acknowledgments

This work was performed under the NASA Glenn Research Center GESS Contract # NAS3-00145.

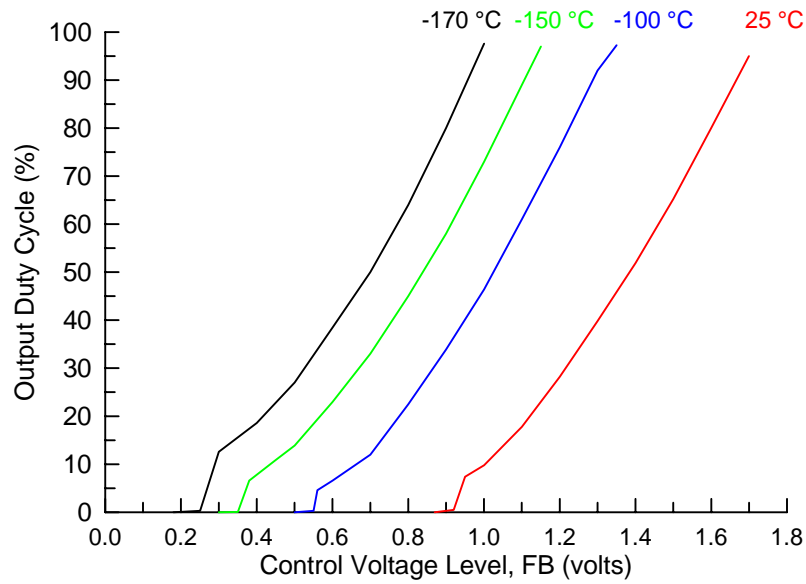


Figure 1. Change in duty cycle with control voltage level (FB) at different temperatures.

Table I. Switching frequency and supply inputs versus temperature.

Temperature (°C)	Frequency (kHz)	VCC (V)	ICC (mA)
25	102.9	13	1
-100	103.9	12.71	29
-150	102.5	12.12	29
-170	98.8	13	21